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EU 2050 low-carbon energy future: visions and strategies

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Abstract

In this paper, we analyze the visions presented by stakeholders and the emerging strategies of EU Member States to achieve a low-carbon energy system by 2050. We identify the key challenges in the six energy policy areas, i.e. energy efficiency, greenhouse gas emissions, renewable energy, energy infrastructure, energy market, and technology innovation and R&D. We also find that Member States are already pursuing different strategies to deal with these challenges. This creates new risks for energy policy fragmentation, but it also implies new opportunities for Member States to cooperate, and for the EU institutions to provide added value to national policies.

Keywords

low-carbon, energy policy, European Union, transition,

Introduction

In 2009, the European Council conclusions called upon all parties to embrace the objective of the International Panel for Climate Change (IPCC) to limit climate change to 2°C in 2050 by drastically reducing greenhouse gas emissions.[i] The target for developed countries is considered to be a reduction of greenhouse gas emissions (GHG) of 80 to 95% below 1990 levels by 2050. In 2011, the European Council asked for an elaboration of a 2050 low-carbon

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strategy.[ii] The European Commission responded shortly after by releasing three roadmaps throughout 2011, and as a result, the transition towards a low-carbon energy future is increasingly debated in Europe.[iii]

It is in this context that several EU Member States started to develop a 2050 energy strategy, and that stakeholders have presented their vision for Europe. The strategies we discuss in this paper are from France, Germany and the UK. The visions we analyze are from a diverse set of stakeholders that have been published in 2010: a European electricity industry association (Eurelectric: "Power Choices – Pathways to carbon-neutral electricity in Europe by 2050), representatives of the European gas industry (EGAF: Making the green journey work – Optimized pathways to reach 2050 abatement targets with lower costs and improved feasibility), the European Climate Foundation (ECF: Roadmap 2050 – A practical guide to a prosperous low-carbon Europe), the intergovernmental International Energy Agency (IEA: Energy Technology Perspectives 2010 – BLUE Map Scenario to 2050) and a non-governmental environmental organization in cooperation with an association of the renewable energy industry (EREC/Greenpeace: Energy [R]evolution – A sustainable world energy outlook).

The paper is organized into 3 sections. Section 1 discusses the transition costs and benefits. Section 2 analyzes the stakeholder visions and derives from these visions the main policy challenges. Section 2 then looks at how France, Germany and the UK are already dealing with these challenges. We identify the actual risks of policy fragmentation and the new opportunities for Member State cooperation and European added value.

1. The transition costs and benefits

Stakeholders have presented alternative pathways towards a low carbon energy system in 2050 with slightly different geographic scopes[iv] and GHG emission reduction targets. In what follows, we discuss the differences in assumptions regarding: 1) fuel prices; and 2) technology development.

For the assumed fuel prices, IEA presents low fuel prices, based on the reference scenario of the IEA World Energy Outlook. It is assumed that fuel prices will decrease significantly towards 2050 as a result of the decreasing fuel consumption. ECF fuel prices are slightly higher, based on the low carbon scenario included in IEA World Energy Outlook. EGAF uses the same assumptions on fuel prices as ECF, except for gas where two scenarios are considered: a high gas price scenario with the same gas prices as ECF and a low gas price scenario which assumes that gas price remains low up to 2050. The Eurelectric fuel prices, based on own calculations, are higher than in the reports above. EREC/Greenpeace has the highest assumed fuel prices based on the high price sensitivity scenario in IEA World Energy Outlook.

Looking at the assumed technology developments, stakeholders do not count on the same technologies. For instance, IEA projects that Carbon Capture Transport and Storage (CCTS) will be available between 2015 and 2025, depending on the support that this technology will receive, ECF considers that CCTS technologies will be commercially available from 2020, Eurelectric considers these technologies from 2025, and EGAF from 2030. EREC/Greenpeace does not rely on CCTS technologies. The costs of renewable energy technologies are assumed to reduce in each scenario, but the reduction is reported in different indicators. For instance, Eurelectric presents levelized cost, EREC/Greenpeace refers to the evolution of investment and operation and maintenance costs, while IEA, ECF and EGAF report the learning rates of the different technologies.

Despite the differences in the assumptions among the different visions, their outcomes concerning the overall cost of the transition are considerably similar. The transition increases the need for investments so that capital costs increase, while fuel costs decrease. In Eurelectric's vision, the fuel cost savings do not fully compensate the additional investment needed, compared to their baseline scenario. In the IEA's vision, the additional investments are lower than the cumulative fuel savings, compared to their baseline scenario. In ECF's vision, the cost of energy is reported to decline by 20-30% over the total period. EGAF however argues that the ECF pathways are costlier and riskier than accounted for. The EREC/Greenpeace study reports an annual cost of electricity supply that is below their baseline scenario. In other words, the visions agree that investment will go up, and fuel costs will come down, but they do not agree on the net effect.[v]

Some stakeholders have also argued that their findings are robust by showing that they also hold under different assumptions. For instance, Eurelectric performed four sensitivity analyses in order to study the impact of changing their main assumptions, including the delay on CCTS technologies development, a change in nuclear phase out policies, stricter restrictions regarding on-shore wind installation and the inexistence of additional energy efficiency policies. The overall result is that in general there are no significant changes, neither on the target achieved nor in the overall costs of the transition. IEA also performed sensitivity analysis regarding assumptions in the different economic sectors (electricity, buildings, industry and transports) in order to guarantee the robustness of their conclusions. The main goal of the ECF sensitivity analysis has been to show that the power system can sustain a high share of renewable energy sources, even when considering extreme weather conditions and/or reductions on interconnections.

2. Energy policy challenges for 2050

In this section, we identify the key challenges for the six energy policy areas, i.e. energy efficiency, greenhouse gas emissions, renewable energy, energy infrastructure, energy market, and technology innovation and R&D.

First, the policy area of energy efficiency. The key challenge reported by stakeholders is to achieve ambitious energy savings. The comparability of the visions is however limited because they do not use the same indicators for savings. Eurelectric and EREC/Greenpeace, for instance, report primary energy savings relative to the reference scenario in IEA world energy outlook, i.e. 20% for and 40%, respectively. IEA and ECF express energy savings as GHG emissions' reductions, which is 30% in the case of IEA, while in the case of ECF this is 45% for buildings and 20% for transport.

Second, the policy area of GHG emissions. The key challenge reported by stakeholders is to achieve a nearly zero-carbon electricity sector. The vision is to generate electricity mainly from low-carbon energy technologies, i.e. using renewable energy sources, nuclear and/or fossil fuels equipped with carbon capture transport and storage (CCTS) so that electricity can play an important role in decreasing also the emissions of the transport and heating sectors. Eurelectric considers the highest level of electrification for both sectors, followed by the ECF vision, while EREC/Greenpeace and IEA consider a higher direct use of renewable energy sources and a lower use of electricity. In the EGAF vision, a major contribution comes from shifting from coal to gas power plants with also an increased penetration of renewable technologies and the application of combined cycles to biomass power plants.

Third, the policy area of renewable energy. The key challenge reported by stakeholders is to achieve the ambitious renewable energy targets. There is an agreement that the use of renewable energy sources needs to continue to increase, both directly and indirectly. Renewable energy is projected to account for 30-34% (EGAF) up to almost 100% (EREC/Greenpeace) of electricity generation in 2050. ECF presents three different visions with different shares on the use of renewable sources within the electricity sector, ranging from 40% to 80%. IEA envisages that 50% of the electricity is produced from renewable energy sources. EGAF suggests postponing the main increase of renewables until 2030.

Fourth, the policy area of energy infrastructure. The key challenge reported by stakeholders is to ensure electricity grid adequacy. The importance of the electricity grid, and especially the expansion of transmission across borders, is emphasized in all visions. The expansion of interconnections that needs to be achieved ranges from a 40% to almost 400% increase compared to today's capacities in the most extreme scenarios of ECF with 80% renewable energy without improvement of demand side flexibility. ECF also shows the potential benefits of using demand flexibility to reduce the need for transmission expansion, and EREC/Greenpeace advocates for a EU super-grid.

Fifth, the policy area of the internal energy market. The key challenge reported by almost all stakeholders is to ensure electricity supply security. Depending on the visions, the increase in generation capacity ranges from 50% (Eurelectric) to 164% (ECF 80% RES) of today's generation capacity. This raises concerns for timely investments, which is especially the case for investments in system flexibility. As the amount of back-up capacity that will be needed is uncertain, depending on the generation mix and the electricity transmission grid

expansion, there are concerns that the market will not deliver in time or will not provide enough system flexibility.

Sixth, the policy area of technology innovation and R&D. The key challenge that is implicit in all the visions is to develop the technologies that are not yet available, and to reduce the costs of technologies that are already available. Indeed, technology innovation is required to address the challenges in the other policy areas: achievement of highly ambitious savings requires the use of technologies which are still not commercially available; the almost full decarbonisation of the electricity sector strongly relies on improved renewable energy technologies and the development of CCTS technologies; and research on smart grids.

3. Strategies to deal with the key 2050 energy policy challenges

In this section, we analyze the strategies that are emerging at EU Member State level to deal with the key challenges that have been identified in the previous section. We focus on France,[vi] Germany[vii] and the UK[viii], illustrating new risks for policy fragmentation, and new opportunities for cooperation among Member States, and for the EU institutions to provide added value to national policies.

To achieve ambitious energy savings (i.e. key challenge for the energy efficiency policy area), France, Germany, and the UK see a lot of potential in their building sectors. In France, the target is to achieve a 38% reduction of the overall energy consumption within the building sector by 2020. In order to achieve this, they intend to develop stricter building regulations for both new and refurbished buildings, defining minimum performance standards and minimum annual refurbishment rates. In Germany, the target is to reduce the overall energy consumption by 20% by 2020 and by 50% by 2050 relative to 2008 levels. A special fund has been established to subsidize a wide range of energy saving measures for consumers, industries and local communities, and stricter building regulations for both new and existing buildings will be developed. In the UK, the government launched the “Green Deal”, a plan to provide up-front financing of energy efficiency improvements that the consumer pays back through their energy bills. In other words, we do see that the building sector is strongly targeted by low-carbon energy policies at member state level, but the approaches seem to diverge substantially.

Regarding the decarbonisation of the electricity sector (i.e. key challenge for the GHG emissions policy area), France, Germany, and the UK have in common that they only consider low-carbon technologies for 2050, but the views regarding their relative importance diverge widely. In Germany (after the Fukushima accident), nuclear is not an option anymore, instead, gas is expected to play an important role during the transition towards renewable energy. In France, nuclear remains an important technology, which in combination with the 2020 target to achieve 20% renewable energy, implies that the French electricity system will be almost decarbonized by 2020. In the UK, the government wants to

push CCTS, and also nuclear is still considered as a valid low-carbon option. In other words, there are diverging strategies in terms of generation mix, and a first illustration of policy fragmentation is the decision of the UK government to introduce a carbon floor for electricity generation from 2013.

Concerning the achievement of the ambitious renewable energy levels (i.e. key challenge identified for the renewable energy policy area), especially Germany wants to continue to push these technologies beyond 2020. The original Energiekonzept strategy aims to have renewable energy for 50% of the electricity consumed in 2030, going up to 65% in 2040, and 80% in 2050, but these numbers might change now that nuclear will not anymore be the bridging technology in Germany. In any case, the Germany strategy relies on the national support scheme to push its strategic renewable energy technologies. In the UK, renewable energy technologies will be supported, but without targets because the intension is to also support the alternatives CCTS and nuclear. In other words, also regarding renewable energy policies, there are new risks of policy fragmentation.

Regarding electricity grid adequacy (i.e. key challenge for the energy infrastructure policy area), important actions are foreseen in Germany and the UK. The German strategy is to develop the national grid to connect offshore wind farms, deploy smart meters, and to integrate national grids into an EU-grid. In the UK, the mandate of the regulator has been redefined, to also include taking care of future consumers by supporting the transition towards a low-carbon energy system. The regulator has already designed a new regulatory regime for grids to allow grid companies to develop the grid that is needed to enable the decarbonization of the electricity system. In other words, there are new opportunities to cooperate, as there seems to be a willingness to further integrate national transmission grids.

To ensure electricity supply security (i.e. key challenge for the internal energy market policy area), there are different strategies. The German strategy is to support integration of the electricity (and gas) markets. In France and the UK, the ongoing market reform process risks to be a step back in the ongoing integration process. In both markets, the intension is to develop a national generation capacity mechanism. In the UK, tendering is also considered as a possible alternative to mitigate the security of supply risk, which would be more compatible with the current European market framework. The cases of France and the UK illustrate that generation capacity mechanisms are increasingly considered at member state level, and because these mechanisms are currently national in scope, there is a new risk of electricity market fragmentation in Europe.

Regarding technology development (i.e. the key challenge for the technology innovation and R&D policy area), action is considered at national as well as at EU level. In France, public funding for the R&D in the energy sector has always been largely focused on nuclear energy. Following the Grenelle debate, the French government has decided to allocate more than a billion Euros up to 2012 in research for energy efficiency, low carbon transportation,

renewable energy and CCTS. In Germany, the focus is on renewable energy, energy efficiency and energy storage. In the UK, the Department of Energy and Climate Change is supporting low carbon energy research in general, and it is funding demonstration and pre-commercial deployment projects via the Environmental Transformation Fund and the Low Carbon Investment Funding.

Conclusion

The studies by stakeholders show different visions of a low carbon energy system in 2050. However, they agree on the challenges regarding the six energy-related policy areas to achieve these visions: 1) energy efficiency - to achieve ambitious energy savings; 2) greenhouse gas (GHG) emissions - to go towards a nearly zero-carbon electricity sector; 3) renewable energy - to achieve an ambitious renewable energy technologies penetration level; 4) energy infrastructure - to ensure electricity grid adequacy through the expansion and smartening of the grid; 5) internal energy market - to ensure electricity supply security through timely investments and system flexibility; and 6) technology innovation and R&D - to guarantee sufficient technology development for the achievement of the previous challenges.

As we have illustrated with the 2050 low-carbon energy strategies that are emerging in France, Germany, and the UK, there are new risks of policy fragmentation, but also new opportunities for cooperation among member states and for the EU institutions to provide added value to national policies. The main risks for policy fragmentation that we identified are the UK government decision to introduce a national carbon price floor for electricity generation from 2013 onwards; and the possible introduction of purely national generation capacity mechanisms to address the security of electricity supply concerns in France and in the UK. We however also see new opportunities for cooperation among Member States, such as the apparent will of Germany and the UK, to further integrate their electricity transmission grid to enable their low-carbon energy strategies.

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[i] October, 2009 (15265/1/09 REV 1): *"The European Council calls upon all Parties to embrace the 2°C objective and to agree to global emission reductions of at least 50%, and aggregate developed country emission reductions of at least 80-95%, as part of such global emission reductions, by 2050 compared to 1990 levels; such objectives should provide both the aspiration and the yardstick to establish mid-term goals, subject to regular scientific review. It supports an EU objective, in the context of necessary reductions according to the IPCC by developed countries as a group, to reduce emissions by 80-95% by 2050 compared to 1990 levels."*

[ii] February, 2011 (EUCO 2/1/11 REV 1): *"The European Council looked forward to the elaboration of a low carbon 2050 strategy providing the framework for the longer term action in the energy and other related sectors. Reaching the EU objective, in the context of necessary reductions according to the IPCC by developed countries as a group, of reducing greenhouse gas emissions by 80-95% by 2050 compared to 1990 as agreed in October 2009 will require a revolution in energy systems, which must start now. Due consideration should be given to fixing intermediary stages towards reaching the 2050 objective. The European Council will keep developments under review on a regular basis."*

[iii] See: 1) Jones, C., Glachant, J., 2010. "Toward a zero-carbon energy policy in Europe: defining a viable solution." The Electricity Journal. 23(3): 15-25; 2) Delarue, E., Meeus, L., Belmans, R., D'haeseleer, W., Glachant, J.-M., 2011. "Decarbonizing the European electric power sector by 2050: a tale of three studies," EUI Working Papers, RSCAS 2011/03; 3) Policy Proposal by Jacques Delors, 2010. "Towards a European Energy Community: A Policy Proposal." Report by S. Andoura, L. Hancher, and M. van der Woude; 4) Meeus, L., 2012. "Appraisal of the European Commission's Energy Roadmap 2050," European Energy Journal, Issue 3, pp. 48-54.

[iv] Eurelectric considers EU 27, while both EGAF and ECF consider all the countries from EU 27 plus Switzerland and Norway. The scope from IEA and EREC/Greenpeace reports is OECD Europe which consists of 19 EU member states (Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Netherlands, Poland, Portugal, Slovak Republic, Spain, Sweden and United Kingdom) plus Iceland, Norway, Switzerland and Turkey.

[v] Note that the stakeholder studies included here assess the policy costs mostly from an energy system analysis. Transformational policies such as those needed to achieve a low carbon economy are however likely to have impacts on various sectors of the economy and on the trading balance of the EU, which can be negative (e.g. reduced competitiveness of energy intensive industries) and/or positive (e.g. development of low carbon businesses). Note also that the stakeholder studies compare the costs of the transition with a "business as usual" baseline scenario, which is actually not the correct way to discuss whether or not we should follow the decarbonisation path, we should rather be comparing the costs of climate change with the costs of the transition to mitigate climate change.

[vi] In France, the government initiated a debate with different stakeholders (including local authorities, trade unions, business, NGOs) on ecological and sustainable development in 2007, i.e. the "Grenelle de l'environnement". This has already led to two legal commitments, i.e. "Grenelle I", enacted in 2009, that sets the general policy without practical implementation or funding, and "Grenelle II", released in 2010, which defines specific targets and actions. Note also that 201 decrees need to be implemented for the laws to become effective, which is foreseen for 2012.

[vii] In Germany, the government has developed its low-carbon energy policy, i.e. "Energiekonzept" based on the Prognos study that models different scenarios on the future of the German energy sector. The law corresponding to the "Energiekonzept" was supposed to be voted in 2011, but after the recent events in Japan, Germany is reconsidering its strategy.

[viii] In the UK, the government established the Committee on Climate Change and used its advice to develop a low carbon energy system transition plan. A first legislative action has already been accomplished in 2008 with the Climate Change Act, mandating to cut GHG emissions with 80% by 2050 relative to 1990 levels. An additional law, the Energy Act 2010, was voted in April 2010 in order to implement part of the transition plan prepared by the government. Finally, there is the Energy Act 2011, establishing the Green Deal, which has been enacted on 18 October 2011.